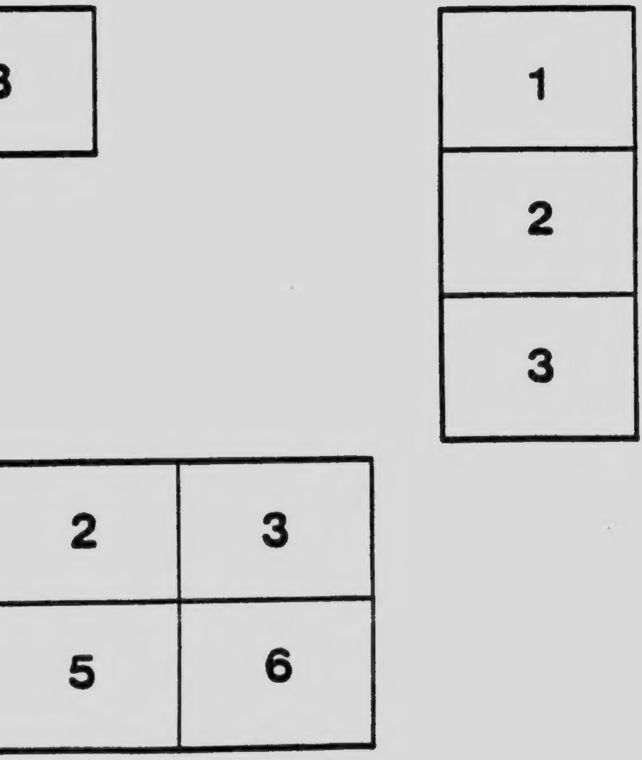
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WITH COMPLIMENTS OF THE AUTHOR.

Fraser's System

OF

CONCRETE CRIBWORK

Construction.

1904

PATENTS GRANTED IN CANADA AND UNITED STATES AND APPLIED FOR THROUGHOUT THE WORLD.

J. N. Doody

FRASER'S SYSTEM

OF

CONCRETE CRIBWORK

CONSTRUCTION.

Patents granted in Canada and Unites Stated and
applied for THROUGHOUT THE WORLD.—

Ottawa, 31st January 1904

Dear Sir:—

Your attention is respectfully called to the contents of this brochure, which is issued for the purpose of introducing to you the "System of Concrete Cribwork Construction."

The main features sought for by the writer in asking the public to adopt this method on the construction of hydraulic works, is permanency combined with economy.

These features are the chief attainments striven after by all who have selected the motto: "Let us render things permanent by improvement or otherwise if such can be done with economy."

This brochure is not intended for advertising, nor does it contain any matter which pertains to the science of engineering, but it is submitted only as an elucidation of the system and some advice as to the methods to be employed.

If after reading the matter over carefully, you find any serious objections to the practical application of this system, on the works herein mentioned, the writer would be happy to be informed. If on the other hand the invention meets with your entire approval an endorsement is respectfully asked for.

Hoping that the introduction of the "system" will be accepted with popular favour by those in a position to judge of its merits, and that it will be attributed to the humble efforts of the writer in promoting permanence and economy in one class of engineering works.

The contents are respectfully submitted,

60 College Avenue.

J. C. Fraser.

Concrete Structures built of Structural Members

Inventions or improvements which benefit humanity at large are usually adapted with delight by those interested and are immediately considered a blessing. Other classes of inventions are accepted by many with certain reserve which requires conclusive proof to ultimately obtain the desired recognition of the invention or improvement. A third class is accepted with distrust by the public, and is not generally adopted until people are educated to the advantages to be derived from the invention.

In introducing my present invention to the public, civil engineers and builders more especially, I earnestly hope that mine may be placed in the first category, and by the publishing of the following description to place myself beyond doubt above the second.

All civil engineers and others who are interested in the construction of quays, breakwaters, docks, wharfs, &c., will admit that the use of timber in such works has always been considered an unsatisfactory make-shift and it has been their earnest endeavour, for years past, to devise plans for making such works of a permanent character and which would not require to be rebuilt every eight or ten years.

Stone and cement have been used successfully to reduce the cost of maintenance, but the primary cost has been so great that the interest charges have been as much as the charge for repairs and maintenance on a timber structure, therefore, such works have been considered almost prohibitive; and there are very few such works, built of stone and concrete, in this country; but where such concrete works are built they are usually placed on a timber substructure while the superstructure is built with retaining walls of concrete, filled between the walls with earth and stone filling to form the body of the structure.

The cost of such a work over a similar work, all in timber is about 30 p.c.

The unsatisfactory timber structure is yearly becoming more expensive and difficult of construction owing to the increasing scarcity of dimension timbers; and the exhorbitant cost of permanent works in stone and cement being almost prohibitive, it is evident that a new departure must be made in the construction of reasonably cheap and permanent quays, docks, wharfs, &c., therefore my object, in introducing Fraser's System of Concrete Cribwork, which invention I have recently patented and I claim that my invention will be both economical and permanent.

After preparing a design or plan, giving specific dimensions of each piece or part, a mould is made of wood or metal to the desired length or form, and the mould is filled with concrete composed of cement in proper proportion with sand, gravel or broken stone, so as to form what may be called the "members."

By so constructing the moulds these "members" may be dovetailed or jointed, like timbers; holes left at the points of contact for the insertion of iron pins or rods of sufficient sizes to well secure together every part of the structure and to stand the required strain according to the class of work required: therefore the invention consists in the principle or system of building all kinds of cribwork, form and mode of construction varying with the circumstances of the case or the fancy of the designer, with concrete pieces formed, jointed and framed like timber pieces used in all kinds of cribwork, designed in any form.

This principle or system to be utilized in the construction of wharfs, dams, locks, dry docks, piers, abutments, bridge piers, retaining walls or cribwork superstructures or any other structure.

The concrete to be used to form such pieces, necessary for any of the above mentioned works, may be made of any kind of cement mixed in satisfactory proportions with other materials and may or may not be reinforced with metal. The cement may also be used neat, that is without the incorporation of any other material.

Reinforcement

The concrete members may require to be reinforced by iron bars being incorporated into the member during the process of manufacture.

In the case of a member 12 by 12 inches square and 20 feet long, I believe that four corrugated or twisted iron rods, ½ inch in diameter, placed at the four corners, about two inches within the faces of the members, would be amply sufficient to give them all the rigidity required for purposes of handling and putting in place and that when in the work their strength, crushing and tensile, will be much greater than that of any soft timber now employed in hydraulic works.

During the process of moulding members it will be necessary to attach sunken ring-bolts or hooks, to facilitate the slinghing into position and thereby guard against injury.

For small or simple works the moulds may be made of plank but I believe that it would be preferable from every point of view that they should be made with channel iron as shown in plate No 1, fig. 4. Such moulds would be perfectly rigid and economical and could be made to any desired length, are easily put together and bolted to place, then held together by iron, straps at the top and screw bolts at the bottom. After the concrete had set the sides could be removed and the member permitted to rest on the bed until it had become hard; the sides could be used on other beds while the first member was drying.

A single mould could be utilized to form a large number of different styles of members. Alterations inside the mould could be obtained to form notches, voids, dovetails, &c., by inserting wood or cast-iron blocks of the required shape into the mould before casting.

To make members twelve inches square and twenty feet long, such iron mould would weigh from 1500 to 2000 pounds and could be built for sixty to eighty dollars. These being interchangeable could be taken apart and moved to other works when required.

In a seasons' time each mould could be used to form about ninety members of different lengths and shape.

By increasing the size of the mould members of any size form and length may be built.

To avoid cohesion between the members and the moulds, it will be found necessary to apply on the inner faces of the mould, greasy matter, or soft soap, before casting each member.

Economy in building

The cost of building cribwork superstructures and other works with my system may be reduced considerably below the actual present cost of building timber cribwork with stone filling, by filing the chambers with earth instead of stone as is done, at present with timber work.

In such a case it would be advisable to build the outer walls of the work perfectly tight in order to protect the filling against the wash of water. This may be done by placing a string of oakum or other packing between the outer layers of pieces, when being laid one on top of the other.

Filling with earth can always be done for at least $\frac{1}{3}$ of the cost of stone filling, and as the filling of cribwork usually forms 9-10 of the bulk of the work, the reduction in cost would amount to 33 p.c. for 9-10 of the bulk; and assuming that a portion (say half the height of the structure) of the cribbing were constructed under my system it would cost less than double the price of timber cribbing, 25c to 40c, but the adoption of earth for filling would reduce the cost of the whole work by nearly 17 p.c.

It may be claimed that timber cribwork in its present form could also be filled with earth in order to reduce its first cost; but the very fact that the superstructure of timber cribwork is of a perishable nature, forbids the use of earth for filling, as the decay of timber weakens the structure, when it is easily damaged by the elements, and in that condition the cribbing could not hold the earth filling against the eroding effects of water. Besides, earth filling would accelerate the decay of the face timbers of superstructures.

The saving in construction, as above stated, would be more than sufficient to pave the whole work with stone blocks, if so desired, after the filling had fully settled or packed, ensuring permanency of every portion of the work.

It may appear, at first sight, to some, that the substitution of stone for earth, for filling or ballasting cribwork, would reduce the weight of a structure, thereby endangering its stability if the work be exposed to storms, or to pressure of any kind, unless its bulk be increased to meet the deficiency.

Following is the average weight of a cubic foot of any material that may be used for filling:

Boulders, from ½ to 3 ft. in dia., mixed	100 to 120 lbs
Clay, moderately packed.	100 to 110 "
Earth, common loam, wet, well pressed	110 to 120 "
Gneiss, run of quarry up to 4 ft. dia.	90 to 100 "
Gravel or sand, moist	115 to 130 "
Limestone, quarried in irregular fragments	90 to 100 "
Mud, wet, moderately pressed. . . .	110 to 130 "

From the above it may be seen that gravel or sand, earth, mud and clay weigh generally more than the ordinary stone ballast on account of the large voids that are unavoidable in the latter.

Earth would form a very compact filling giving a degree of elasticity that would have the effect of deadening any blow the structure might receive.

Under this system of cribwork also, the substitution of timber pieces for concrete members in the superstructure adds considerably to the weight of the structure and helps to permit of the use of other materials for filling even lighter than those above named, such as, ashes, broken brick, &c.

If stone filling is adhered to, the bulk of the work would cost about $1\frac{3}{4}$ p.c. over present cost of timber cribwork.

Concrete Piles

I may here say that concrete is rapidly taking the place of timber and even of masonry in a number and different classes of works, and so far this material has proved a success both from a point of strength,

durability and economy, where the correct method of construction has been applied to a particular work. Probably one of the latest encroachments, of concrete on timber, is the use of that material for forming piles for foundations, &c. We are informed by scientific publications that very severe tests were made recently, in Germany, with piles of 15 feet in length and not quite a foot in dimension by driving them into firm ground, with a hammer weighing 4,000 lbs. after which they were taken out and redriven four times in succession without in any way damaging the heads or any other parts of them. This repeated driving having thereby proven, that well made reinforced concrete piles can stand even more abuse than timber piles, which certainly would have been split on the second driving, not to speak of the greatly increased load these piles will carry in excess of timber piles. The experience so far gained by engineers, in making and driving piles of concrete, is a convincing proof that these offer many advantages, can be cheaply made and will, in the near future, be used extensively. They have already been utilized to build foundations for large public buildings in the United States and Europe, where solid ground was encountered only at great depths.

I may be allowed here to remark that if piles can be put into a work in such a satisfactory condition, there cannot be any doubt in the facility that will certainly be experienced in putting concrete members together to build cribwork in place.

Combined timber and Concrete

In my system the use of two distinct or different materials is permissable, the lower portion of the cribwork, which is constantly submerged, may be composed of timbers, while the upper portion or superstructure is formed of concrete members having the general shape of timbers. These latter members, or "timbers" as they may be termed, are molded, as already described, before being placed in position. The lower or timber portion proper will be so treated

as to render it proof against the attack of the toredo (when submerged in salt water), or other marine life. As will be readily seen, the superstructure, by reason of the material of which it is composed, is proof against the attack of the limnoria, and the entire cribwork is thus permanently protected. Furthermore, the wooden substructure being constantly submerged is never exposed to the air, which condition also tends to prolong its life.

The advantages derived from the employment of a structure of this character are many, both from the constructor's point of view and as regards stability and duration. It is well known by those who have had experience in the construction of cribwork, first: that timber of different kinds is the only material which, up to the present time, has been successfully utilized in the construction of cribwork; second: that cribwork composed of timbers is perishable, having only short duration when exposed to the weather, and requiring the reconstruction of its superstructure about every eight years; third: that frequently the timbers composing the exterior surface of the body of the cribwork do not offer sufficient resistance to the elements especially after being weakened by decay, and the structure is often damaged by moving ice-floes and from other causes; and fourth: that cribwork built in salt water is exposed, in some localities to destructive worms which attack the foundation of the structure and very often cause its partial or total collapse.

The most active of these worms are the toredo nevalis and the limnoria tenebrans; the former attacks all kinds of natural timber submerged, while the latter attacks only the timber lying between high water and a foot or so below low water.

Even where creosoted timber has been used in superstructures to counteract the destructiveness of these worms, it is not expected to [illegible]t the destruction by the elements for more than [illegible]ive years. The cost of this material in the work is generally 65 cents per cubic foot.

By the use of the system which I have devised, the above objections to cribwork, as at present constructed, are pratically overcome. The substitution of concrete members in the superstructure, in place of

ordinary timber heretofore employed, insures a permanent cribwork, and repairs will not be required unless the structure should become accidentally damaged In case of injury by accident the superstructure may be as easily repaired as timber cribwork. The employment of concrete to form the diffeffrent pieces of the superstructure renders the cribwork sufficiently strong to withstand the destructive seas, and the pressure and eroding effects of ice-floes, and would be free from the attacks of worms.

Under my present invention the substructure may be started and built afloat for half of its height, more or less, with timbers which have been creosoted or treated in any other desired manner or other timbers. The concrete pieces may then be put in place until the timber portion or substructure has almost lost its buoyancy, at which time the cribwork may be set in position by adding more concrete pieces, (if then found high enough to reach the surface of the water after it has been sunk to the bottom.) This method of sinking obviates the necessity of piling stones on top of a crib to set it in position.

If it be found that the timber utilized does not provide sufficient buoyancy to permit of the construction of the concrete work to the required height or to bring the structure sufficiently high out of water after touching the bottom, the cribwork may be held up by the use of scows or the like until the desired height has been reached, when the whole structure, together with the scows, can be sunk. The scows will, of course, afterwards be floated.

This method renders the work of starting the permanent construction under low water very easy, and economical which is not usually the case, especially in connection with the construction of concrete retaining walls, as it is difficult and expensive to prepare a foundation for surh work under the water.

Where the substructure is not subjected to the attack of worms, that portion of the cribwork may be composed of timber in its natural state, for, as is well known, wood which is constantly submerged is not perishable. Again, the interior of the superstructure may be built partly of untreated timber, especially if the chambers of the cribwork are to be filled with earth, which will have the effect of burying the

timbers and insuring their presservation. The use of this earth filling is practical as regards both permanence and economy, but as already stated it cannot be employed to fill cribwork composed entirely of timber.

The necessity for the use of coffer-dams and the like is obviated by my invention.

In the case of retaining-walls this system of concrete cribwork can be adopted with great advantage and at a considerable reduction in cost. Retaining-wals of a permanent nature are generally built of heavy masonry, or of monolithic concrete, requiring an artificial foundation if laid on soft material. The same may be said of heavy lock-walls forming the chamber of a lock, and applies equally as well to dry-dock-walls, abutments of bridges, breakwaters, jetties, and the like. In tidal water it is difficult to build concrete in place, as the constant rising of the tide washes away a portion of the cement before the concrete is set. Besides this, the large and expensive molds required for such works are in constant danger of being damaged by the waves, ships, etc., while under my system no such moulds are required in exposed places, as all parts are formed in moulds upon the land or upon barges or vessels especially designed for this purpose. This process also allows a rigid inspection of each member to be made, if desired, before allowing them to be placed into the work.

The invention is somewhat illustrated in the accompanying plates, in which:

Plate No 1. Fig. 1 represents a cross-section of the combined timber and concrete members, framed in one particular style of open-faced cribwork, and the mode of attachment of the members and the sheathing on one face of the work.

Fig. 2. is a plan of this cribwork representing the joinings.

Fig 3. represents one method of interlocking members .

Fig. 4 is a section of a mould, made of standards channels, to cast the " members " with.

Plate No 2.—Fig. 1 represents a crosse-section of the combined timber and concrete members, framed in another particular style of close-faced cribwork with the combined use of timber and concrete mem-

bers in the superstructure, and the mode of attaching horizontal fenders on one face. This figure also shows a covering of stone blocks which can be easily built by the saving made in the substitution of earth filling in place of stone.

Fig. 2 is part of an elevation of such work

Fig. 3 represents the method of dovetailing and joining the members.

Plate 3.—Fig. 1 represents a cross-section of the combined timber and concrete members framed in still another style of close-faced cribwork with the combined use of timber and concrete members in the superstructure, with the covering made of stone blocks.

Fig. 2. is part of the elevation of this class of work.

Fig. 3 represents a method of reinforcing the members.

Fig. 4 represents the dovetailing and joining of such members.

In the above described plates letter "C" denotes the concrete members which as already stated are formed in moulds, at a point remote from the cribwork; letter "D" represents an opening at the point, where the various members and timbers intersect and which opening is to be filled with grout before the introduction of the iron rods "E" and letter "K" represents the chambers of the cribwork to be filled with earth or stone as may be desired.

The particular composition of the concrete employed and its reinforcement is immaterial so long as the resulting member is sufficiently stable for the purpose in view. Again, the particular form or contour of the members is immaterial, it being only necessary that they be capable of being readily handled and assembled. It is, of course, essential that the members be so formed that they may be securely fastened together, as well as to the substructure and with this end in view they are notched or recessed, or prepared in any other suitable manner, this being merely a matter of detail of construction. By preference each member, and the receiving top timbers of the substructure, will be provided with an opening, at the points where the various members and timbers intersect, and iron rods passed down into these open-

ings after the cribwork is completed, the openings being subsequently filled with grout. Any other suitable arrangement may, of course, be adopted for trying the whole structure together.

If desired, the superstructure may be sheathed or protected by fenders, recesses being formed in the outer faces of the concrete members in the process of molding, for the reception of bolts which are secured therein by cement or the like. The sheathing or fenders are in turn to be secured in place by the bolts.

Conclusion

In presenting the above description of my invention to the public, I have no hesitation in stating that all my claims are reasonable and when adopted by civil engineers, builders and others will prove a great benefit to the public.

All admit that concrete is now being extensively used satisfactorily for different purposes, what objection is there to its further use by casting members in moulds to the desired form or dimension and placing them in the work as you would a piece of timber?

The small quantity of concrete used in forming these members, to construct a skeleton frame, is undoubtedly cheaper than a work of like dimension built of solid concrete.

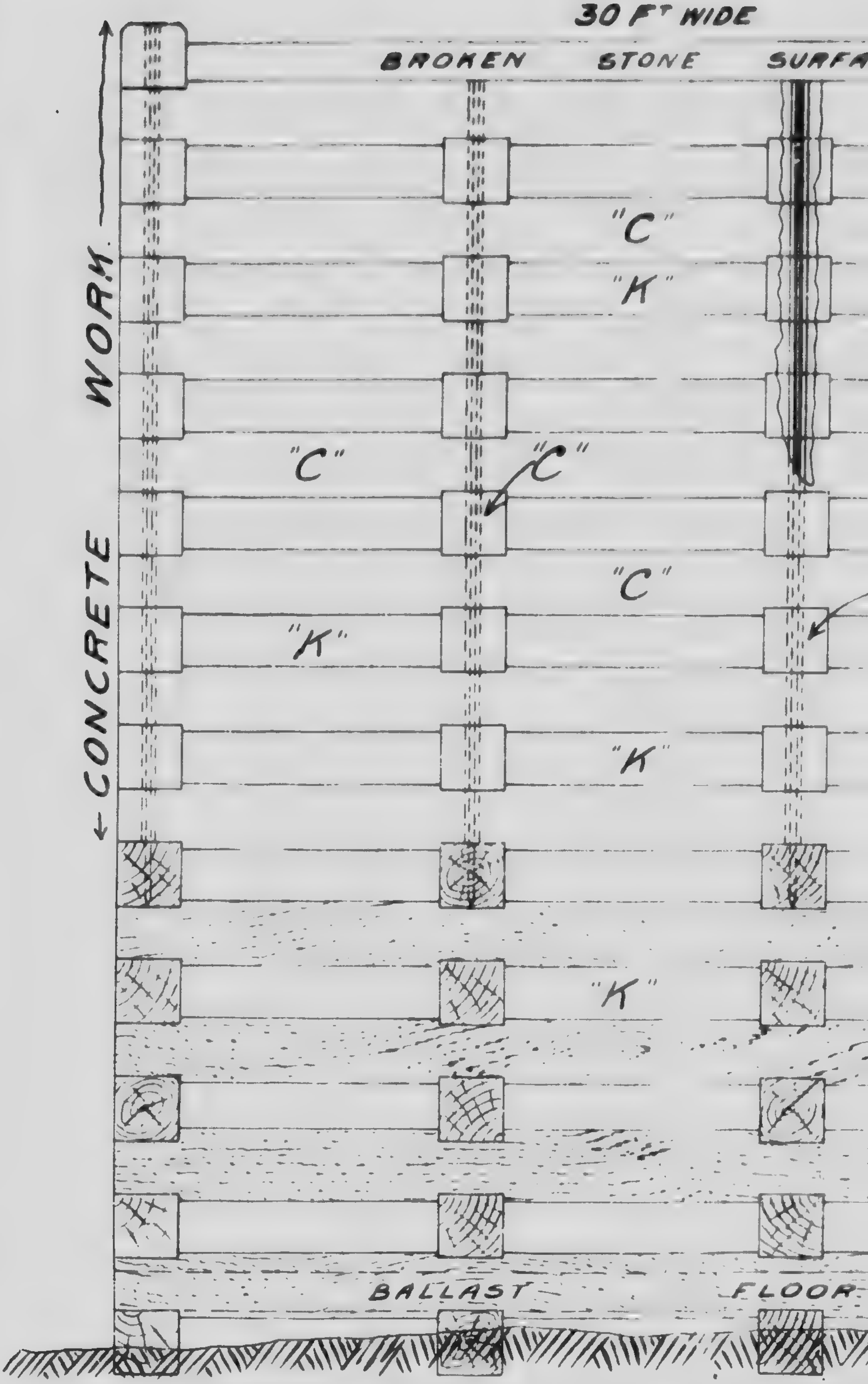
If stone filling be used in the cribwork built with concrete members, I admit the primary cost will be somewhat more than for ordinary timber work similarly filled, but the ultimate cost after 10 years service will be less; if earth filling be substituted for stone the primary cost of a work will be 17 p.c., less and more in a number of cases.

I further claim that my invention will in a short space of time, be used for almost all kinds of framing where heavy timbers are now used.

Respectfully submitted,

J. W. FRASER,
A. M. Can. Soc. C.E.

Ottawa, 31st. January 1904.



CROSS SECTION OF ONE CLASS

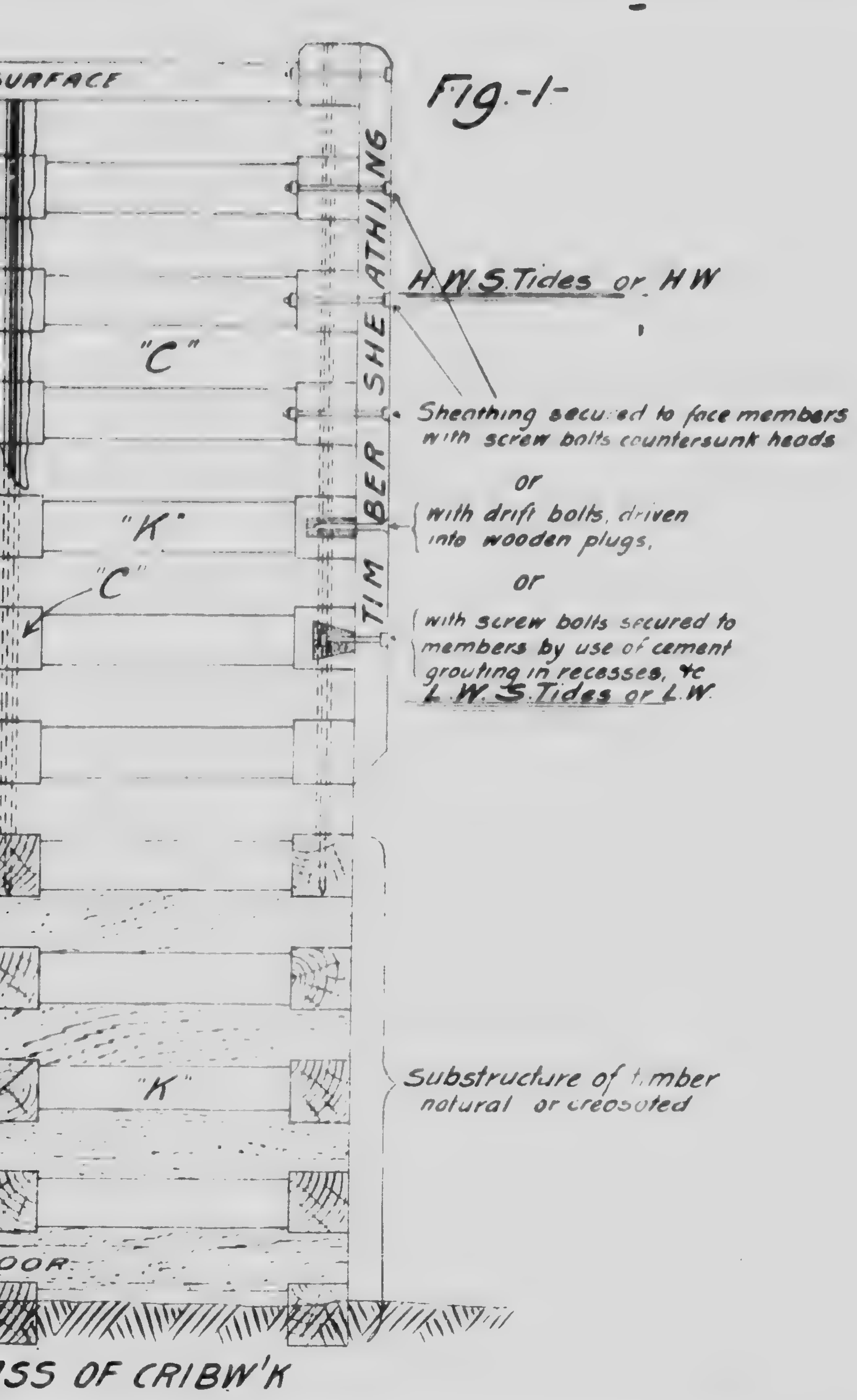
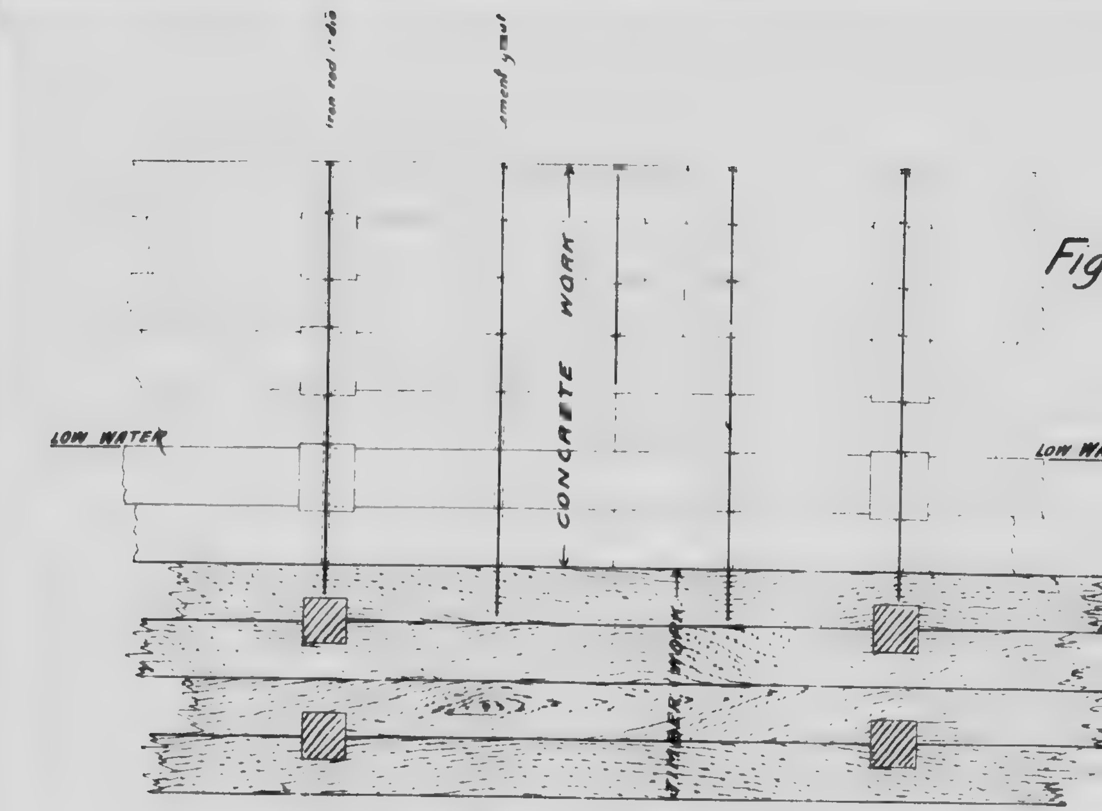
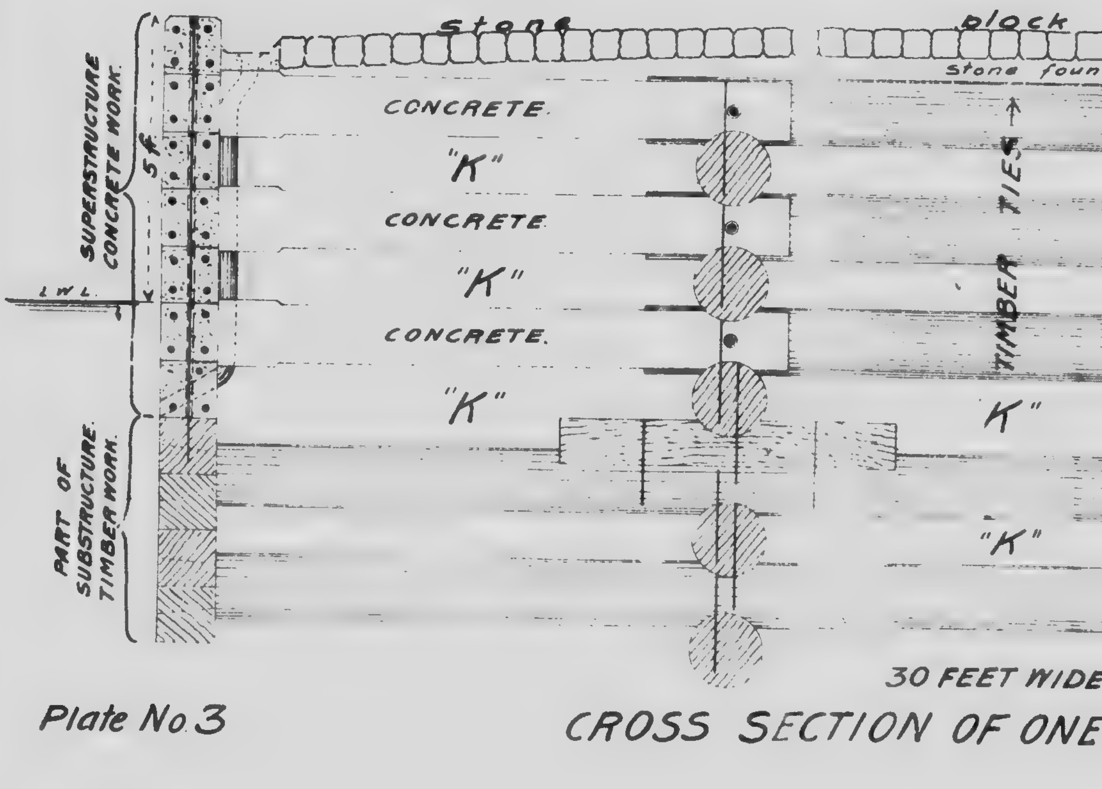


Fig.-1-
SURFACE
TIMBER SHEATHING
H.W.S.Tides or H.W
"C"
Sheathing secured to face members with screw bolts countersunk heads
or
with drift bolts, driven into wooden plugs,
or
with screw bolts secured to members by use of cement grouting in recesses, &c
L.W.S.Tides or L.W.
"K"
"C"
Substructure of timber natural or creosoted
"K"
OOR
SS OF CRIBW'K

Fig



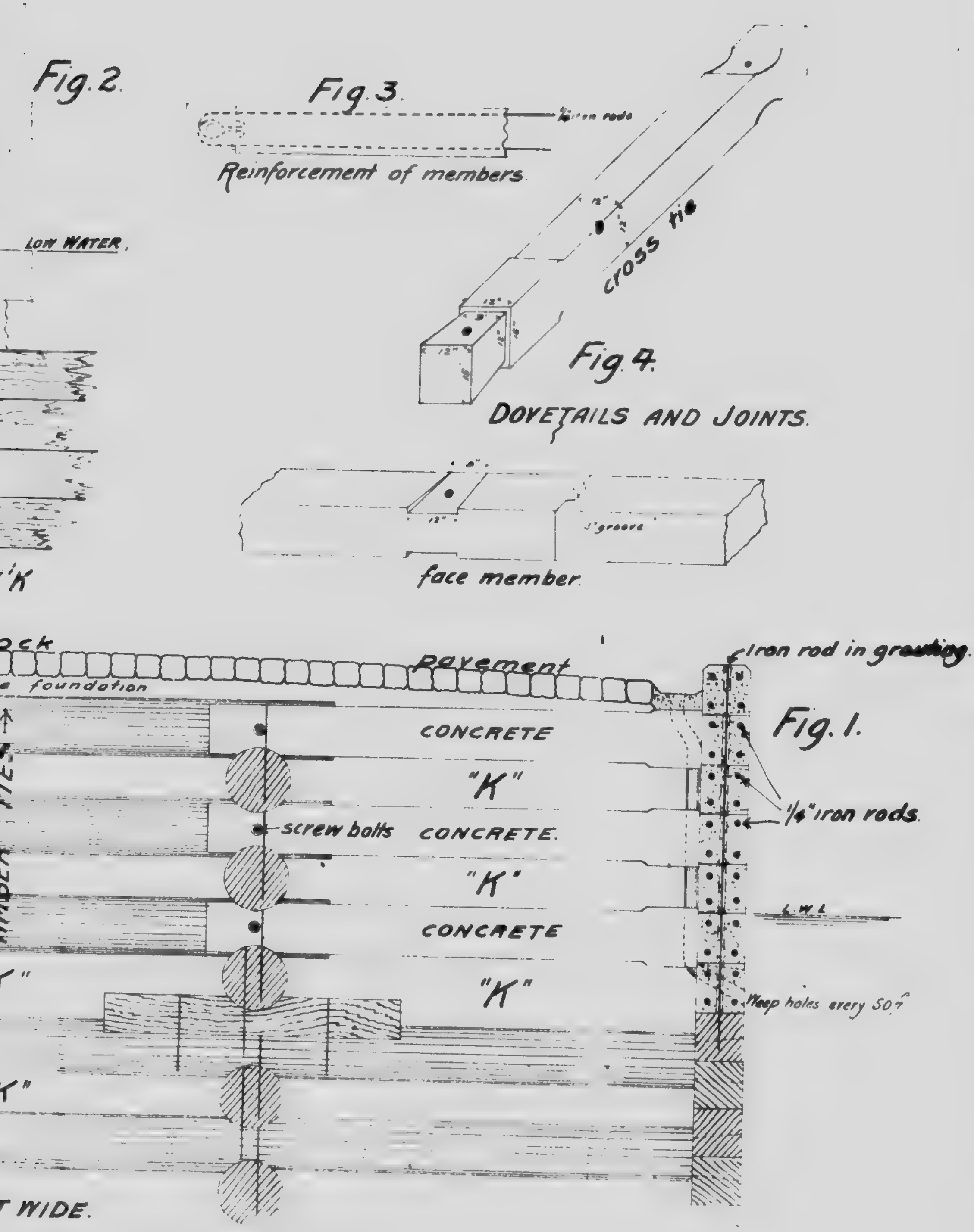
PART ELEVATION OF ONE CLASS OF CRIBW'K



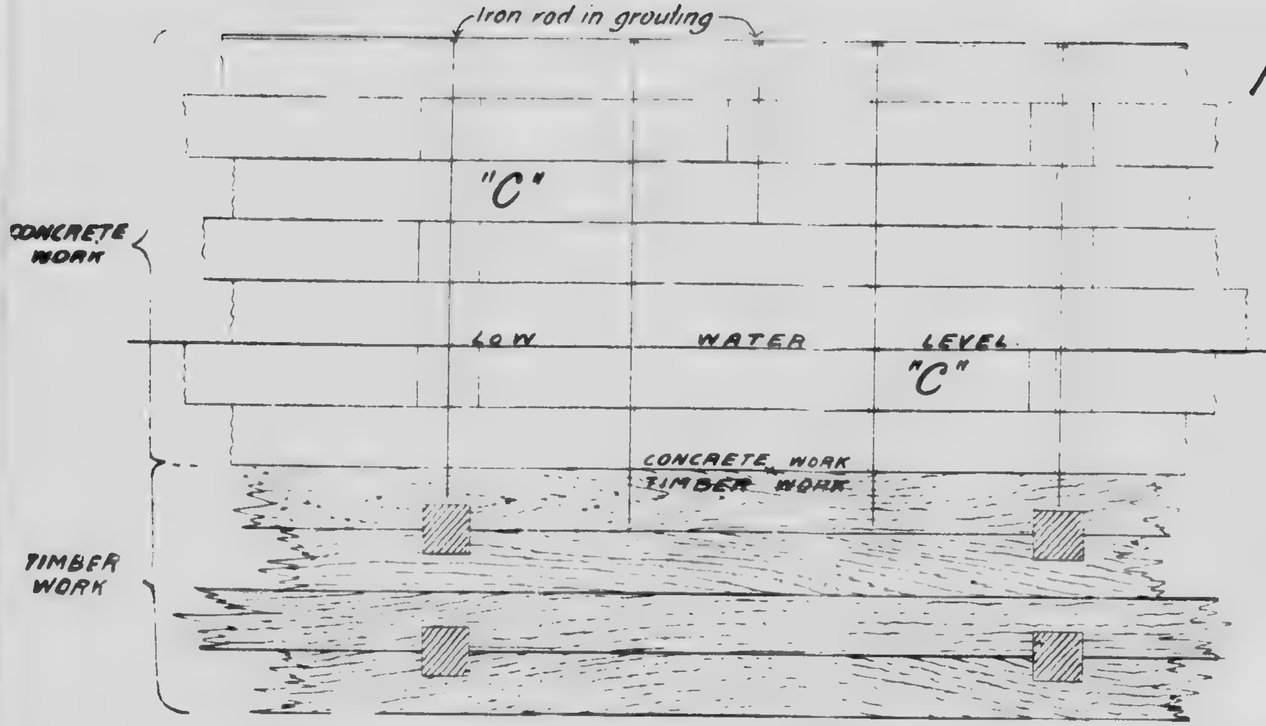
30 FEET WIDE

Plate No 3

CROSS SECTION OF ONE



ONE CLASS OF WORK



PART ELEVATION OF ONE CLASS OF CRIBW'K.

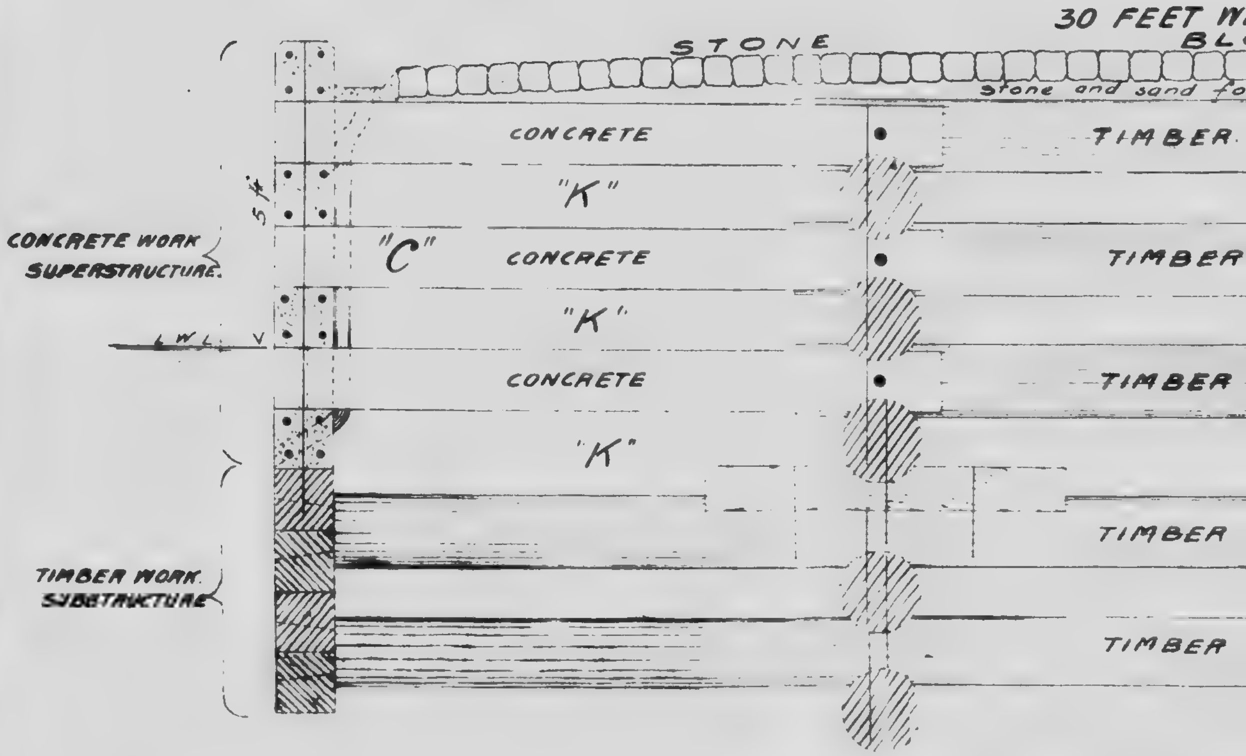


Plate No. 2.

CROSS SECTION OF ·ON

Fig. 2.

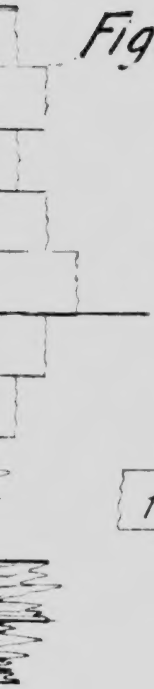
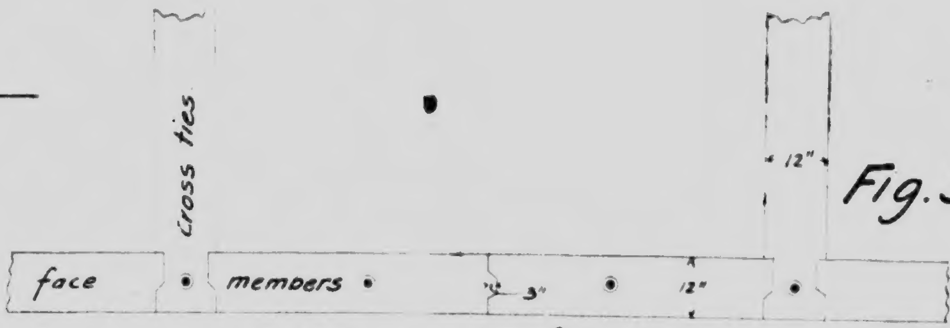
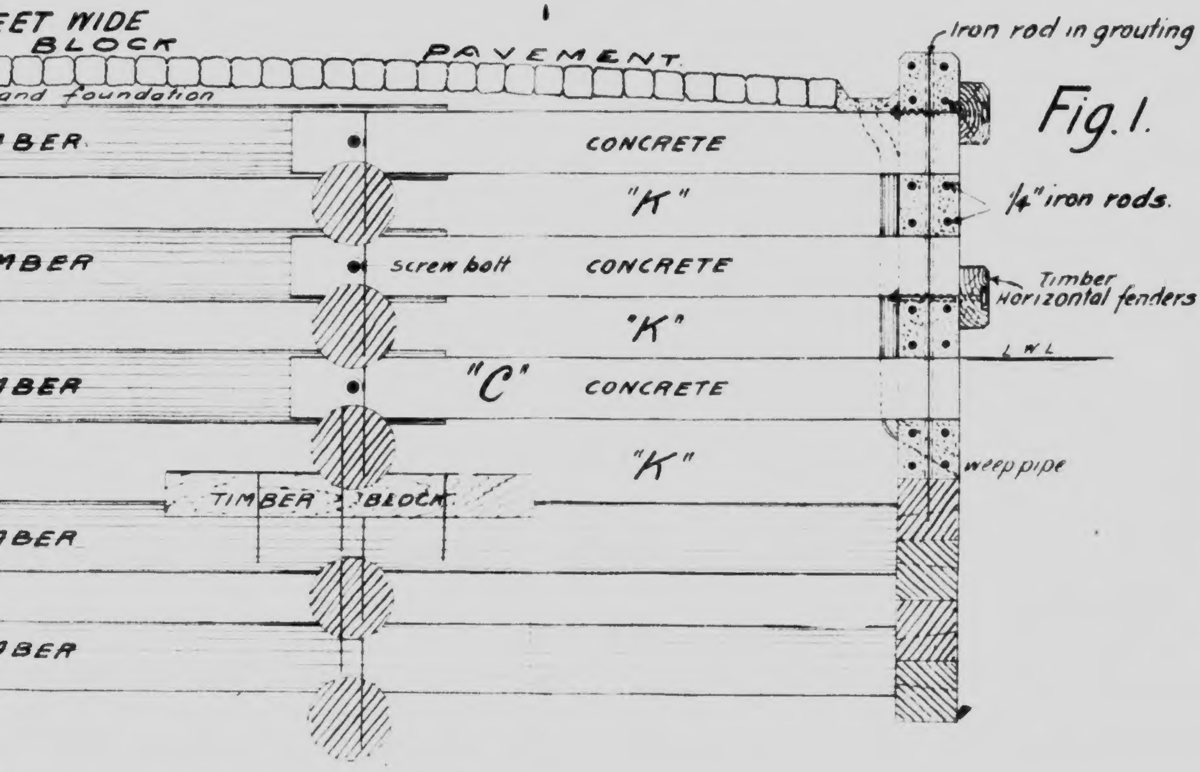


Fig. 3.



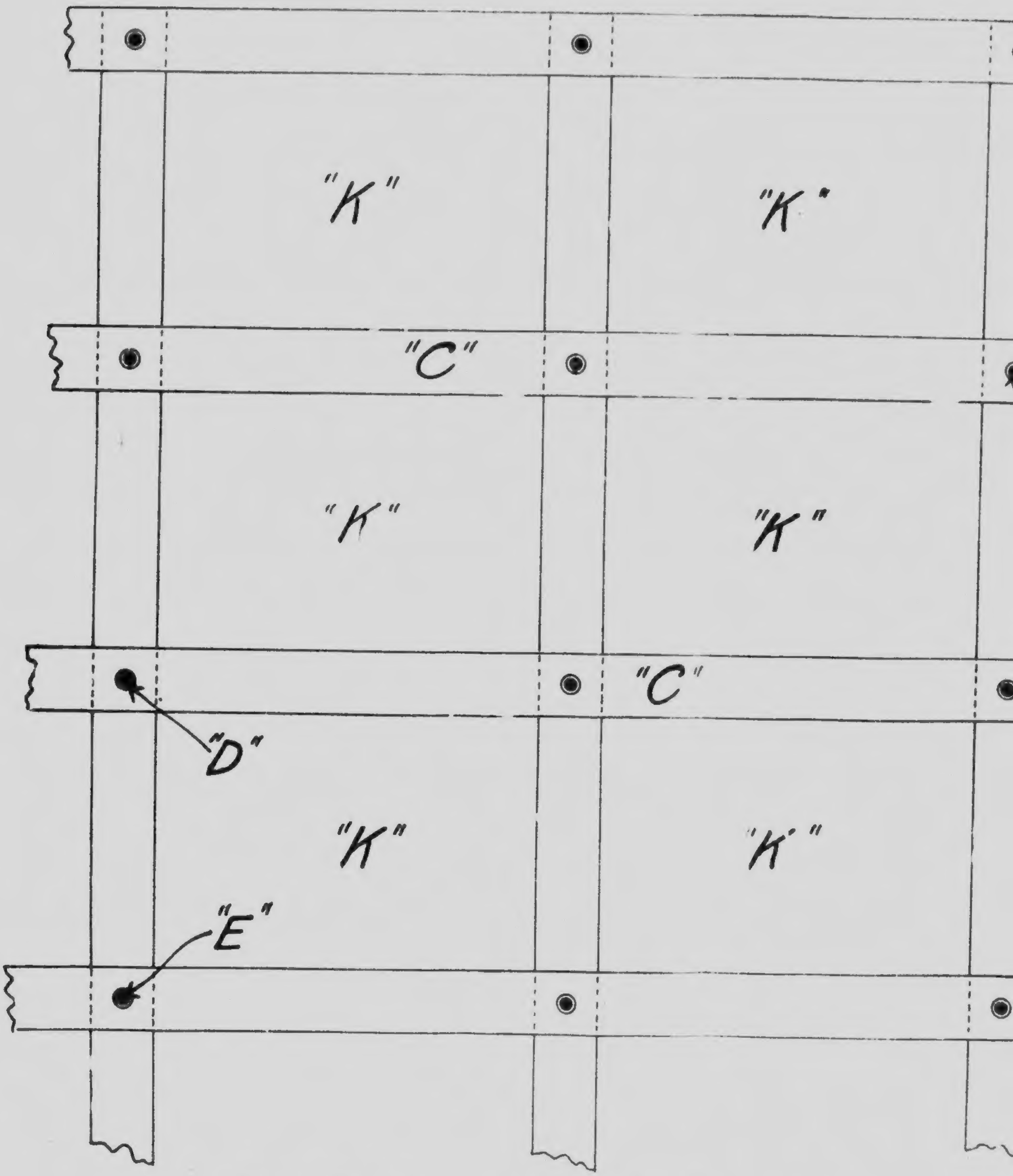
PLAN ~ DOVETAILS & JOINTS

Fig. 1.

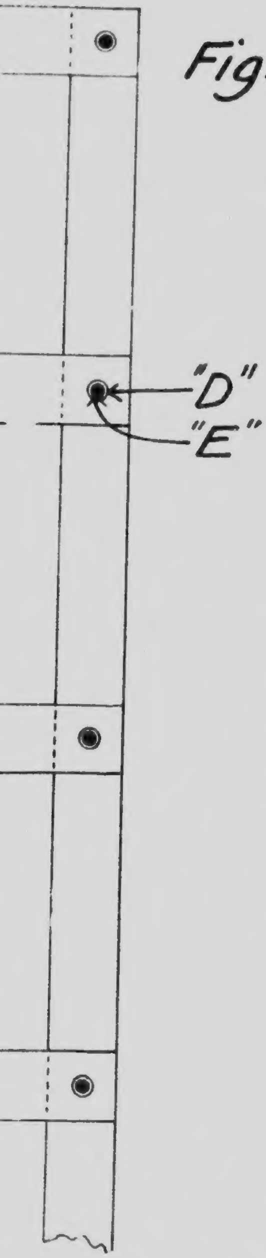


F·ONE CLASS OF CRIBWORK

Plate No. 1.



PART OF [illegible]AN OF ONE CLASS
OF CRIBWORK



INTER LOCKINGS.

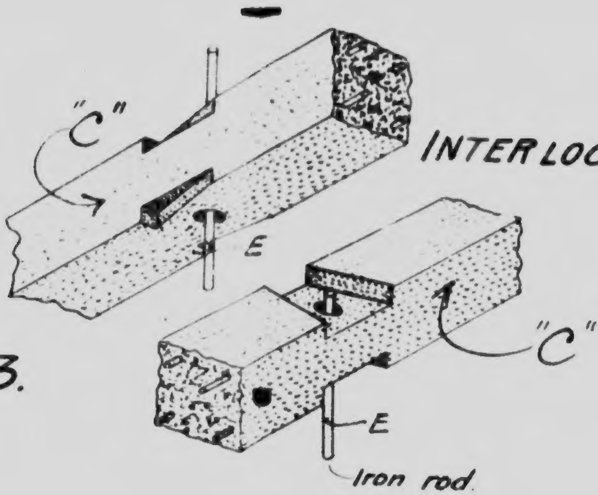


Fig. 2

Fig. 3.

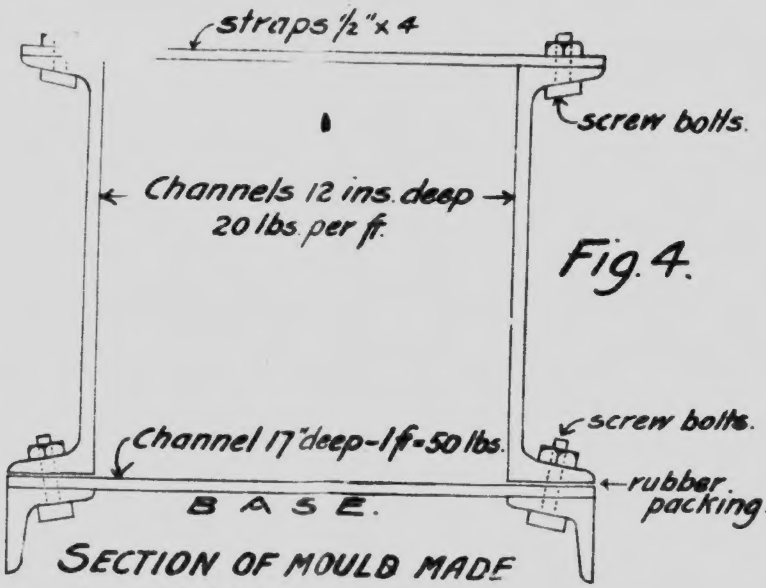


Fig. 4.

SECTION OF MOULD MADE OF CHANNELS, TO CAST 12 INS. SQ. MEMBERS.